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EFFECT OF FREEZING RATE AND METHOD OF RETHERMALIZATION ON THE ORGANOLEPTIC QUALITIES OF ELEVEN MEAT ENTREES

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

A study was conducted in 1977 by the US Army Natick Research and Development Command to determine the energy consumption and costs associated therewith of various heating devices used for rethermalizing food. The effect on food quality was not considered in that study. The study reported herein was a logical extension of the previous evaluation and centered on the evaluation of the organoleptic qualities of food after rethermalization in various heating equipments. Eleven meat entrees were packaged in rigid foil half-size steam table pans or boil-in-the-bag pouches. Portions of each entree were frozen

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either slowly or rapidly. The frozen meat entrees were rethermalized by heating in (a) boiling water, (b) steam cooker, (c) microwave oven, (d) convection oven or (e) standard oven. A technological panel determined that the entrees were satisfactory and would serve their intended purpose if any of the combinations of freezing and method of rethermalization evaluated in this report were used.

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PREFACE

An investigation of the energy usage and the costs associated therewith by various heating devices was conducted by Food Engineering Laboratory, US Army Natick Research and Development Command (NARADCOM) in 1977. The effects on organoleptic factors, color, odor, flavor, texture and appearance, were not considered in that study. A logical follow-on study with eleven meat entrees evaluated the effect of two rates of freezing and five methods of rethermalization on the organoleptic factors cited above. Products were packaged in half-size, rigid foil, steam table pans for rethermalization in a steam cooker, convection oven and standard oven, and in boil-in-the-bag pouches for rethermalization in the microwave oven and in boiling water. A technological panel evaluated the products.

The authors wish to thank Mr. Milton Swanson and Dr. S. E. Wallen for conducting some of the technological evaluations of the meat entrees.

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INTRODUCTION

Swift et al studied the efficiency and cost factors involved in rethermalizing frozen food to serving temperature (71°C).[1] Various heating devices (standard and convection ovens and high- and low-pressure steam cookers) were evaluated. Their work did not cover the organoleptic aspects of rethermalized foods. The work reported herein, therefore, is a logical extension of the work reported by Swift and his colleagues.

The boil-in-the-bag concept of heating foods is not new. Food items are commonly found in the supermarket that are heated to serving temperature by merely immersing the sealed bag in boiling water for 15 to 20 minutes.

The advantages of boil-in-the-bag on the civilian market are convenience and labor savings. They are generally priced slightly higher than their plainly packaged counterparts. In large size units, i.e., five pounds, the economic factor of cost of the package is introduced. A 26-cm by 20-cm by 6.5-cm rigid foil, half-size steam table pan with lid costs about thirty cents per unit at current prices. The cost of a bag constructed of a single laminate nylon has been estimated at nine cents per bag currently.

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[1] Swift, J., S. Conca and J.M. Tuomy. Efficiency and cost factors in rethermalizing frozen food in typical dining hall equipment. Natick/TR-78/014. (1978).

In addition to the economic factors, some other advantages seen for the boil-in-the-bag method of handling foods are: (a) reduction in freezer burn by minimizing contact of the product with air. Foil pans can have the entire surface of the product (520 cm^2) exposed to the head space atmosphere; (b) reduction of the surface browning or crusting during reheating which reduces usable yield; (c) reduction of loss of volatile nutrients through escaping steam; and (d) simpler, more fool-proof preparation in the dining hall. There is the future possibility of immersion-freezing of the bags which is not feasible with the foil pan. Therefore, if a large proportion of the frozen entrees proposed for production at a facility such as the Central Food Preparation Facility at Fort Lee, VA could be packaged in boil-in-the-bag pouches, a considerable savings in packaging material and costs could be realized. Some improvement in product quality might also result. The savings in required storage freezers could also be substantial.

This report is concerned with the results of an evaluation of eleven meat entrees packed in either boil-in-the-bag pouches or foil pans; frozen at two rates, and rethermalized in one of five ways; i.e., boiling water, steam cooker, microwave oven, convection oven, and standard oven.

MATERIALS AND METHODS

Materials. Nine of the entrees were prepared by following the production guides found in Technical Report TR 74-27 FEL.[2] Chicken Cacciatore and Roast Beef were prepared using other recipes. The eleven entrees prepared for this study were:

a. Creamed Ground Beef

b. Chili Macaroni

c. Barbecued Beef Cubes

d. Beef Stew

e. Swiss Steak with Tomato Sauce

f. Roast Beef

g. Chicken Cacciatore

h. Oven Fried Chicken

i. Turkey a la King

j. Pork Chop Suey

k. Baked Tuna and Noodles

For convenience, these production guides and the recipes for Chicken Cacciatore and Roast Beef are reproduced herein and are contained in Tables A1 to A11, in the Appendix.

Preparation and Packaging. Each product was prepared in sufficient quantity to provide enough material for 16 five-pound containers. Six of the containers were 26-cm by 20-cm by 6.5-cm rigid

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[2]Helmer, R.L. and H.T. Schlup. Meat entree item production guides developed for use in Ft. Lee interim central food preparation facility. TR 74-27 FEL (FEL-12) March 1975.

foil half-size steam table pans. The aluminum lids were mechanically crimped onto the pans to insure a tight seal. Ten bags constructed from a single laminate nylon film tube were prepared. Each bag was sealed once on the bottom and twice on the top. The purpose for the double seal on the top closure was to account for any product or wrinkles in the seal area. Four of the bags were used for the test. Two bags had thermocouples sealed in them and were connected to a recorder to indicate when the proper temperature for the product was reached. Four bags were used as reserve product in case of breakage or other mishap.

Freezing. Three aluminum pans and five bags of each product were frozen in a conventional freezer operating at -10°C. An equal number of containers were frozen in a blast freezer operating at -29°C. After freezing, all product was stored at -10°C until tested.

Rethermalization. Five methods of rethermalization were evaluated. In each instance, product was rethermalized to an internal temperature of 71°C except roast beef which was rethermalized to an internal temperature of 63°C. Residence times in the various heating devices were adjusted so that product did not remain on the heated serving unit for an excessive time before serving.

a. Standard oven. A Vulcan gas range, Model 17845A, Style 9-66[a] was used for the convection oven. Heating times ranged from 1.5 to 2 hours.

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[a]Vulcan-Hart Corporation, Baltimore, MD

b. Convection oven. A Blodget oven, Type RE-43[b] was used for the convection oven. Heating times ranged from 1.25 to 1.5 hours.

c. Steamer. A Flexseal Speed cooker[c] was used to rethermalize product by steam. Approximately one hour was required for heating at 103 kPa.

d. Microwave oven. A Litton Menumaster[d] microwave oven was employed for this heating test. Approximately 30 minutes was required to heat samples in the microwave oven. Product packed in bags was used in the microwave oven.

e. Steam kettle. A 40-gallon, 1/2 steam jacketed kettle[e] was used to heat the boil-in-the-bag samples. The bags were placed in a wire basket to keep them from floating and to facilitate removal from the water. One hour was the average time to heat product to an internal temperature of 71°C.

Evaluation. Each product was evaluated by a panel of trained food technologists. Products were evaluated for color, odor, flavor, texture, and appearance on a 9-point scale where 9 is excellent, 5 is fair, and 1 is extremely poor.

Analysis of data. The averages of the panel scores were analyzed for significant differences by a standard analysis of variance method.

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[b] G.S. Blodget Co., Burlington, VT

[c] Vischer Products Co., Chicago, IL

[d] Litton Industries, Minneapolis, MN

[e] Lee Metal Products, Inc., Philadelphia, PA

RESULTS AND DISCUSSION

Examination of the averages of the panel scores presented in Table 1 indicates that the freezing rate and the method of rethermalization had only minor effects on the color of the products. The Analysis of Variance (ANOVA) of the color data confirms this conclusion (Table 2). Some differences were noted by the technologists preparing the products for panel testing. The products rethermalized in foil pans tended to brown at the edges of the pan with a slight oil separation in some of the items. The microwave rethermalized products tended to form brown streaks. These differences were discounted by the panelists or not observed in the individual portions evaluated by the panel.

The average panel scores for odor of the entrees are shown in Table 3. Examination of the scores for Oven Fried Chicken revealed that when the product was frozen in the blast freezer, the odor of the Oven Fried Chicken rethermalized in the convection oven was very slightly preferred over the odor of chicken rethermalized by the four other methods. This was not observed when the Oven Fried Chicken was frozen in the standard freezer. With both methods of freezing, Oven Fried Chicken rethermalized in the standard oven rated lower than chicken rethermalized by the other methods.

Table 4 presents the results of the ANOVA for the ratings of the odor of the eleven entrees. Only the odor of Oven Fried Chicken was significantly affected ($p > 0.05$) by the method of rethermalization. No other significant differences were revealed by the ANOVA.

Examination of the panel data for Creamed Ground Beef (Table 5) shows that the product rethermalized in the standard oven was the least preferred. However, the panel gave the product a satisfactory rating. It is likely that a consumers' panel would not detect any differences that could be attributed to the method of rethermalization.

The flavor scores of Roast Beef frozen in the standard freezer was preferred when the item was rethermalized in the boil-in-the-bag pouch or in the convection oven over Roast Beef rethermalized by the other three methods (Table 3). Roast Beef frozen in the blast freezer and rethermalized in the convection oven was preferred over product rethermalized by the other methods (Table 5).

Table 6 shows the results of the ANOVA of the flavor scores of the eleven meat entrees. The method of rethermalization significantly affected the scores for Creamed Ground Beef ($p > 0.01$) and Roast Beef ($p > 0.05$).

The method of freezing had no significant effect on the flavor of any of the entrees.

An interaction was noted between the freezing rate and method of rethermalization for Creamed Ground Beef ($p > 0.01$) and for Baked Tuna and Noodles ($p > 0.05$). It is probably that the interactions are the result of a synergistic effect in that one or neither of the variables studied have a significant effect but together the effect becomes statistically significant.

The data in Table 7 show that Beef Stew frozen in the standard freezer and rethermalized in the steam cooker or the microwave oven had a texture that was preferred over the texture of the Beef Stew rethermalized in the boil-in-the-bag pouch, the convection oven, or the standard oven. The rate of freezing and the method of rethermalization did not affect the texture of the other entrees significantly.

The freezing rate had a significant effect ($p > 0.05$) on the texture of Beef Stew (Table 8). The data in Table 9 show that for Beef Stew product frozen in the blast freezer and rethermalized in the microwave oven had an appearance that less preferred than Beef Stew rethermalized by the other methods. When Beef Stew was frozen in the standard freezer product rethermalized in the convection oven and in the standard oven received lower scores for appearance than Beef Stew rethermalized by the other methods.

Roast Beef rethermalized in the steam cooker was rated lower by the panel than when rethermalized by the other four methods. Roast Beef frozen in the standard freezer and rethermalized in the boil-in-the-bag pouch received a higher average panel score than for the other methods of rethermalization.

Examination of the data in Table 9 shows that Baked Tuna and Noodles frozen in the standard freezer and rethermalized in the steam cooker was preferred less than product rethermalized in the other heating devices. When Baked Tuna and Noodles were frozen in the blast freezer, the product rethermalized in the convection oven rated lower than product rethermalized by the other methods. The highly significant

interaction ($p > 0.01$) is probably the result of a synergism between the two variables.

Average panel scores (Table 9) show that fast freezing was very slightly preferred to slow freezing. The average panel ratings indicated the product had an acceptable appearance.

The ANOVA (Table 10) for the effect of freezing rate and method of rethermalization on the appearance of the entrees shows that the method of rethermalization significantly affected (p 0.05) the appearance of Beef Stew, Roast Beef, and Baked Tuna and Noodles.

The data in Table 10 shows that the freezing rate significantly affected the appearance of Turkey a la King.

All of the entrees evaluated in this study were acceptable to a technological panel regardless of the freezing rate or the method of rethermalization. Over ninety-seven percent of the average panel scores were 6.0 and above, and over twenty-one percent were 7.0 and above.

CONCLUSIONS

1. The entrees studied in this work can be frozen and rethermalized by the boil-in-the-bag method described herein without serious adverse effect on the acceptability of the products.

2. The rate of freezing has little or no effect on the organoleptic qualities of the entrees.

RECOMMENDATIONS

1. The boil-in-the-bag method should be evaluated in a production situation such as at a Central Food Preparation Facility.

2. The ease of preparation of the boil-in-the-bag should be evaluated against the standard half-size foil pan in a dining hall feeding situation.

This document reports research undertaken at the US Army Natick Research and Development Command and has been assigned No. Natick/TR-78/024 in the series of reports approved for publication.

Table 1. Average panel ratings of the color of eleven meat entrees

Method of Reconstitution	Creamed Ground Beef		Chili Macaroni		Barbecued Beef Cubes		Beef Stew		Swiss Steak w/Tomato Sauce		Roast Beef		Chicken Cacciatore		Oven Fried Chicken		Turkey a la King		Pork Chop Suey		Baked Tuna and Noodles	
	S*	F**	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F
Boil-in-the-bag	6.6	6.4	7.3	7.2	6.9	6.9	6.8	6.8	7.0	6.8	6.5	6.4	7.0	6.8	6.6	6.5	6.7	6.8	7.0	7.1	7.0	7.1
Steam Cooker	6.3	6.4	7.3	7.1	6.9	6.9	6.7	6.8	6.8	6.8	5.8	6.0	7.0	6.9	6.7	6.4	6.8	6.8	6.8	7.0	6.8	7.1
Microwave Oven	6.5	6.4	7.3	7.2	6.9	7.0	6.6	6.7	6.9	6.9	6.2	6.3	7.0	6.8	6.4	6.3	6.8	6.8	7.0	7.0	6.9	7.0
Convection Oven	6.3	6.7	7.0	7.1	6.7	6.8	6.8	6.7	6.9	6.9	6.3	6.2	6.8	6.9	6.6	6.6	6.8	6.8	7.0	7.0	7.0	6.9
Standard Oven	6.3	6.2	7.2	7.2	6.9	7.0	6.7	6.7	6.8	6.6	6.2	6.3	6.9	7.0	6.6	6.4	6.8	6.8	6.9	7.0	7.1	7.0

*Slow Freeze. Standard freezer operating at -10°C.

**Fast Freeze. Blast freezer operating at -29°C.

Table 2. The effect of freezing rate and method of rethermalization on the color of eleven meat entree items as judged by a technological panel

Meat Entree	Freezing Rate	Method of Rethermalization	Interaction
Creamed Ground Beef	ns*	ns	ns
Chili Macaroni	ns	ns	ns
Barbecued Beef Cubes	ns	ns	ns
Beef Stew	ns	ns	ns
Swiss Steak w/Tomato Sauce	ns	ns	ns
Roast Beef	ns	ns	ns
Chicken Cacciatore	ns	ns	ns
Oven Fried Chicken	ns	ns	ns
Turkey a la King	ns	ns	ns
Pork Chop Suey	ns	ns	ns
Baked Tuna and Noodles	ns	ns	ns

*Not significant

Table 3. Average panel ratings of the odor of eleven meat entrees

Method of Reconstitution	Creamed Ground Beef		Chili Macaroni		Barbecued Beef Cubes		Beef Stew		Swiss Steak w/Tomato Sauce		Roast Beef		Chicken Cacciatore		Oven Fried Chicken		Turkey a la King		Pork Chop Suey		Baked Tuna and Noodles	
	S*	F**	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F
Boil-in-the-bag	6.8	6.8	7.2	7.1	6.8	6.8	6.6	6.6	6.4	6.6	6.6	6.4	7.0	6.8	6.8	6.8	7.0	6.8	6.8	7.0	7.0	7.0
Steam Cooker	6.7	6.8	7.3	7.1	6.9	6.9	6.7	6.8	6.8	6.8	6.2	6.5	7.0	7.0	6.7	6.8	6.7	6.8	6.7	6.8	7.0	7.0
Microwave Oven	6.8	6.7	7.2	7.1	6.8	7.0	6.6	6.6	6.8	6.7	6.1	6.5	7.0	7.0	6.8	6.8	6.9	6.8	6.9	7.0	7.0	7.0
Convection Oven	6.7	6.8	7.1	7.2	6.9	6.8	6.8	6.8	6.8	6.5	6.6	6.8	7.0	7.0	6.8	7.0	6.8	6.8	7.0	7.0	7.0	6.9
Standard Oven	6.6	6.8	7.2	7.0	6.8	7.0	6.6	6.6	6.6	6.7	6.7	6.5	7.0	7.0	6.6	6.6	6.8	6.8	6.8	7.0	7.1	7.0

*Slow Freeze. Standard freezer operating at -10°C.

**Fast Freeze. Blast freezer operating at -29°C.

Table 4. The effect of freezing rate and method of rethermalization on the odor of eleven meat entree items as judged by a technological panel

Meat Entree	Freezing Rate	Method of Rethermalization	Interaction
Creamed Ground Beef	ns*	ns	ns
Chili Macaroni	ns	ns	ns
Barbecued Beef Cubes	ns	ns	ns
Beef Stew	ns	ns	ns
Swiss Steak w/Tomato Sauce	ns	ns	ns
Roast Beef	ns	ns	ns
Chicken Cacciatore	ns	ns	ns
Oven Fried Chicken	ns	**	ns
Turkey a la King	ns	ns	ns
Pork Chop Suey	ns	ns	ns
Baked Tuna and Noodles	ns	ns	ns

*Not significant

**: $P \geq 0.05$

Table 5. Average panel ratings of the flavor of eleven meat entrees

Method of Reconstitution	Creamed Ground Beef		Chili Macaroni		Barbecued Beef Cubes		Beef Stew		Swiss Steak w/Tomato Sauce		Roast Beef		Chicken Cacciatore		Oven Fried Chicken		Turkey a la King		Pork Chop Suey		Baked Tuna and Noodles	
	S*	F**	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F
Boil-in-the-bag	6.8	6.8	7.0	6.8	6.6	6.8	6.4	6.3	6.2	6.1	6.6	6.1	7.0	7.0	6.5	6.6	6.2	6.4	6.8	6.9	7.0	7.0
Steam Cooker	6.8	6.8	7.3	7.1	6.8	6.7	6.7	6.2	6.1	6.0	6.0	6.0	6.8	6.8	6.7	6.6	6.4	6.6	6.5	6.6	6.8	6.8
Microwave Oven	6.8	6.8	7.1	6.9	6.8	6.8	6.3	6.2	6.2	6.0	5.8	6.1	7.1	6.9	6.4	6.8	6.3	6.6	6.8	6.8	6.8	6.6
Convection Oven	6.8	6.8	6.9	7.0	6.5	6.7	6.4	6.6	6.4	6.1	6.5	6.6	6.8	7.0	6.9	6.7	6.2	6.5	6.9	7.0	6.7	6.8
Standard Oven	6.5	6.5	7.0	7.0	7.0	7.0	6.2	6.3	5.5	6.0	6.0	6.0	6.8	7.0	6.5	6.3	6.3	6.5	6.6	6.7	7.3	6.7

*Slow Freeze. Standard freezer operating at -10°C.

**Fast Freeze. Blast freezer operating at -29°C.

Table 6. The effect of freezing rate and method of rethermalization on the flavor of eleven meat entree items as judged by a technological panel

Meat Entree	Freezing Rate	Method of Rethermalization	Interaction
Creamed Ground Beef	ns	*	*
Chili Macaroni	ns	ns	ns
Barbecued Beef Cubes	ns	ns	ns
Beef Stew	ns	ns	ns
Swiss Steak w/Tomato Sauce	ns	ns	ns
Roast Beef	ns	**	ns
Chicken Cacciatore	ns	ns	ns
Oven Fried Chicken	ns	ns	ns
Turkey a la King	ns	ns	ns
Pork Chop Suey	ns	ns	ns
Baked Tuna and Noodles	ns	ns	**

*: $P > 0.01$

**: $P > 0.05$

ns: not significant

Table 7. Average panel ratings of the texture of eleven meat entrees

Method of Reconstitution	Creamed Ground Beef		Chili Macaroni		Barbecued Beef Cubes		Beef Stew		Swiss Steak w/Tomato Sauce		Roast Beef		Chicken Cacciatore		Oven Fried Chicken		Turkey a la King		Pork Chop Suey		Baked Tuna and Noodles	
	S*	F**	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F
Boil-in-the-bag	6.8	6.8	6.8	7.0	6.5	6.4	6.2	6.2	5.6	5.9	6.3	6.0	7.0	7.0	6.9	6.8	6.5	6.5	6.8	6.8	6.7	6.8
Steam Cooker	6.7	6.8	7.0	6.8	6.8	6.8	6.6	6.1	6.0	6.3	5.5	5.8	6.8	7.0	6.8	6.7	6.5	6.6	6.7	6.8	6.7	6.6
Microwave Oven	6.8	6.8	6.8	7.0	6.4	6.3	6.5	6.0	6.0	6.1	5.8	5.8	7.2	6.9	6.8	6.8	6.5	6.5	6.8	6.8	6.8	6.6
Convection Oven	6.7	6.7	6.5	6.8	6.6	6.8	6.4	6.3	6.9	6.0	5.9	6.1	6.8	7.1	7.1	6.6	6.5	6.5	6.8	7.0	6.4	6.5
Standard Oven	6.6	6.6	6.9	6.8	6.8	7.0	6.2	6.3	5.8	6.0	6.1	5.8	6.9	7.0	6.8	6.7	6.4	6.5	6.6	6.7	6.8	6.8

*Slow Freeze. Standard freezer operating at -10°C.

**Fast Freeze. Blast freezer operating at -29°C.

Table 8. The effect of freezing rate and method of rethermalization on the texture of eleven meat entree items as judged by a technological panel

Meat Entree	Freezing Rate	Method of Rethermalization	Interaction
Creamed Ground Beef	ns	ns	ns
Chili Macaroni	ns	ns	ns
Barbecued Beef Cubes	ns	ns	ns
Beef Stew	**	ns	ns
Swiss Steak w/Tomato Sauce	ns	ns	ns
Roast Beef	ns	ns	ns
Chicken Cacciatore	ns	ns	ns
Oven Fried Chicken	ns	ns	ns
Turkey a la King	ns	ns	ns
Pork Chop Suey	ns	ns	ns
Baked Tuna and Noodles	ns	ns	ns

**: P> 0.05

ns: not significant

Table 9. Average panel ratings of the appearance of eleven meat entrees

Method of Reconstitution	Creamed Ground Beef		Chili Macaroni		Barbecued Beef Cubes		Beef Stew		Swiss Steak w/Tomato Sauce		Roast Beef		Chicken Cacciatore		Oven Fried Chicken		Turkey a la King		Pork Chop Suey		Baked Tuna and Noodles	
	S*	F**	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F
Boil-in-the-bag	6.6	6.4	7.1	7.2	6.8	6.8	6.6	6.7	6.8	6.8	6.6	6.3	6.8	6.6	6.3	6.2	6.7	6.8	7.0	7.0	7.0	7.1
Steam Cooker	6.3	6.4	7.1	7.1	6.8	6.8	6.8	6.6	6.8	6.8	5.9	5.8	7.0	6.8	6.3	6.4	6.8	6.8	6.7	6.8	6.6	6.9
Microwave Oven	6.6	6.3	7.1	7.1	6.8	6.8	6.6	6.3	6.8	6.8	6.3	6.3	6.7	6.5	6.3	6.2	6.6	6.8	7.0	7.0	7.0	6.9
Convection Oven	6.4	6.7	6.7	6.9	6.8	6.8	6.1	6.5	6.8	6.8	6.3	6.2	6.5	6.6	6.5	6.5	6.8	6.8	7.0	7.0	7.0	6.6
Standard Oven	6.3	6.2	7.0	7.1	6.9	7.0	6.3	6.8	6.7	6.8	6.2	6.1	6.8	6.6	6.3	6.3	6.5	6.6	6.8	6.8	7.0	6.9

*Slow Freeze. Standard freezer operating at -10°C.

**Fast Freeze. Blast freezer operating at -29°C.

Table 10. The effect of freezing rate and method of rethermalization on the appearance of eleven meat entree items as judged by a technological panel

Meat Entree	Freezing Rate	Method of Rethermalization	Interaction
Creamed Ground Beef	ns	ns	ns
Chili Macaroni	ns	ns	ns
Barbecued Beef Cubes	ns	ns	ns
Beef Stew	ns	**	ns
Swiss Steak w/Tomato Sauce	ns	ns	ns
Roast Beef	ns	**	ns
Chicken Cacciatore	ns	ns	ns
Oven Fried Chicken	ns	ns	ns
Turkey a la King	**	ns	ns
Pork Chop Suey	ns	ns	ns
Baked Tuna and Noodles	ns	**	*

*: $P \geq 0.01$

**: $P > 0.05$

ns: not significant

APPENDIX

PRODUCTION GUIDES

Table A1. Production Guide for Creamed Ground Beef L-30

Yield: 100 portions Each portion: 1 cup (240 ml)

Ingredients	Percentage	Pounds	Grams	Procedure
Beef boneless, ground	30.04	24.00	10896	1. In a steam kettle of suitable size, brown the ground beef (mixer on slow speed). After browning, drain and discard liquid.
Celery, ground	0.01	0.01	5	2. Add ground celery, pepper, soup and gravy base, and onions to beef. Mix thoroughly.
Pepper, black	0.04	0.03	14	
Soup & gravy base (beef)	2.06	1.65	749	
Onion, dehydrated, (chopped)	1.26	1.01	459	
Starch, Col-Flo 67	2.12	1.70	772	3. While meat is browning, blend starch and flour into half the required water to make a slurry. 4. Turn off steam. With mixer on slow speed, pour in slurry. After thorough blending, heat to thicken. (Cook for 20 minutes at 190°F (88°C).
Flour, wheat, pastry	2.35	1.88	854	
Water	54.18	43.28	19649	
Milk, Nonfat, dry	7.94	6.35	2883	5. Mix milk with remaining water to rehydrate milk. With heat off and mixer on slow speed, blend in milk. Heat to 170°F (77°C) being careful not to scorch. Bring volume to 6.25 gallons (23.28). 6. Weigh 5 lb (2270 g) product into half-size steam table pans or boil-in-the-bag pouches. 7. Cover or seal, label, and freeze.
Total	100.00	79.91	36281	

NOTES: Volume = 6.25 gallons (23.21) 100 portions
1 Cup = 10 oz (284 g) by wt.

Table A2. Production Guide for Chili Macaroni L-28-1

Yield: 100 portions Each portion: 1-1/4 cup (300 ml)

Ingredients	Percentages	Pounds	Grams	Procedure
Macaroni, dry	12.72	6.00	2724	1. Cook the macaroni in 6 gallons of boiling salt-water for 10-15 minutes. Rinse, drain, and cool. Set aside.
Salt	0.42	0.20	91	
Beef, boneless, ground	50.89	24.00	10896	2. Brown beef in appropriate steam kettle. After browning, drain liquid and discard.
Garlic, dehydrated, powder	0.01	0.01	5	3. Add dry seasonings, onions, tomato paste and canned tomatoes to meat. Mix thoroughly and simmer 20 minutes.
Onions, dehydrated, chopped	0.53	0.25	114	
MSG	0.05	0.02	9	
Paprika, ground	0.27	0.13	59	
Pepper, cayenne	0.01	0.01	5	
Salt, table	1.33	0.63	286	
Chili powder	0.79	0.37	168	
Bay leaves, ground	0.01	0.01	2	
Tomato paste (26% solids)	7.09	3.34	1516	
Tomatoes, canned, crushed	25.88	12.21	5543	
				4. Add macaroni, adjust volume to 8 gallons (30.2 l), blend and heat to 180°F (82°C).
				5. Weigh 5 lb (2270 g) of chili macaroni into each half-size steam table pan or boil-in-the-bag pouch.
				6. Cover or seal, label and freeze in blast freezer.
Total	100.00	47.18	21418	

NOTE: Each pan yields 7 portions

Table A3. Production Guide for Barbecued Beef Cubes L-18

Yield: 100 portions Each portions: 6 oz (180 ml)

Ingredients	Percentage	Pounds	Grams	Procedure
Beef, boneless, diced, 1 inch by 1-1/2 inch pieces	54.81	30.00	13620	1. Dredge beef in seasoned flour; shake off excess.
Flour, wheat, pastry	1.83	1.00	454	2. Brown beef cubes in hot
Pepper, black	0.02	0.01	6	shortening in steam kettle.
Salt	0.24	0.13	59	3. After browning, drain liquid
Shortening, melted	3.65	2.00	908	and discard.
Water	27.41	15.00	6810	4. Add one-half of water to beef and simmer for 55 minutes covered.
Onions, dehydrated, sliced	0.91	0.50	277	5. Combine all dry seasonings,
Chili powder	0.26	0.14	64	starch, tomato paste,
Mustard, ground, dry	0.15	0.08	36	Worcestershire sauce, hot sauce
Sugar, light brown	0.47	0.26	118	and remaining water. Mix well
Salt	0.24	0.13	59	and simmer 25 minutes or until
Starch, Col-Flo-67	1.09	0.60	272	meat is tender.
Tomato paste, (26% solids)	6.94	3.80	1725	
Worcestershire sauce	0.48	0.26	118	
Hot sauce, tabasco	0.11	0.06	28	
Vinegar, cider (4%)	1.39	0.76	345	6. Add vinegar, mix well and bring volume back to 5.25 gallons (19.9 liters) with hot water. 7. Place 5 lb, 4 oz (2384 g) in each half-size steam table pan or boil-in-the-bag pouches. 8. Cover or seal, mark and freeze.
otal	100.00	54.73	24849	

OTES:
1. Formula yields 8 pans.
2. Four lb (1816 g) of fresh onions may be substituted in step 5.
3. One gallon weighs 8 lb (3632 g) each cup weighs 8 oz (227 g).
4. Each pan yields 14 portions.

Table A4. Production Guide for Beef Stew L-22

Yield: 100 portions Each portion: 10 oz (284 g)

Ingredients	Percentage	Pounds	Grams	Procedure
Beef, boneless, diced, 1-inch by 1-1/2 inch pieces	35.60	30.00	13620	1. Dredge diced beef in seasoned flour, shake off excess.
Flour, wheat, pastry	0.60	0.50	227	
Salt	0.41	0.35	159	
Pepper, black	0.03	0.02	10	2. Place dredged beef in steam kettle with one-half the amount of water listed. Brown meat and simmer 55 minutes.
Sugar, white, granular	0.24	0.20	90	
Water	29.66	25.00	11350	
Salt	0.41	0.35	159	3. Combine remaining water with salt, thyme, bay leaves, and starch. Mix well and add to simmered beef.
Thyme, ground	0.01	0.01	5	
Bay leaves, ground, fine	0.01	0.01	2	
Starch, Col-Flo-67	0.52	0.44	200	
Carrots, fresh, 1/2-inch rings	9.49	8.00	3632	4. Add all vegetables to simmered beef and seasonings, mix well and simmer 15 minutes (undercook vegetables).
Celery, fresh, 1-inch pieces	4.75	4.00	1816	
Onions, dehydrated, sliced	0.48	0.40	182	
Potatoes, fresh, white, 1-inch to 1-1/2 inch pieces				5. Bring volume back to 8 gallons with hot water (30.2 L).
Tomatoes, whole, canned	8.30	7.00	3178	6. Place 5 pounds, 10 oz (2554 g) in each half-size steam table pan or boil-in-the-bag pouch.
				7. Cover or seal, mark, and freeze.
Total	100.00	84.28	38262	

NOTES: 1. Batch yields 10 pans, each pan feeds 10 men.
2. Three pounds of fresh onions may be substituted in step 4.
3. Weight per gallon 7.5 lb (3405 g), weight per cup 7.5 oz. (213 g).

Table A5. Production Guide for Swiss Steak with Tomato Sauce L-16

Yield: 100 portions
Temperature: 325°F (176°C) Griddle; 325°F (163°C) Oven

Each portion: 1 steak plus 1/2 cup sauce (120 ml)

Ingredients	Percentage	Pounds	Grams	Procedure
Beef, boneless, swiss steak (100 steaks)	38.26	36.00	16344	1. Dredge steaks in seasoned flour. Shake off excess
Flour, wheat, pastry	2.34	2.20	999	
Pepper, black	0.02	0.02	8	
Salt	0.19	0.18	82	
Shortening, vegetable	2.13	2.00	908	2. Brown steaks on well-greased grill. 3. Shingle 50 steaks in each pan and hold for step 4.
Sauce				
Onions, dehydrated, sliced	0.46	0.43	195	4. Combine onions, peppers, garlic powder, pepper, salt, tomatoes, Worcestershire sauce and water, together and pour equally over pans of shingled beefsteaks.
Peppers, sweet, fresh, green, chopped	2.13	2.00	908	
Water, hot	15.26	14.36	6519	
Garlic powder, dry	0.01	0.01	4	
Pepper, black	0.02	0.01	6	
Salt	0.32	0.30	136	5. Cover pans and heat in 325°F (163°C) oven until meat is tender (2-1/2 hours).
Tomatoes, canned, crushed	14.05	13.23	6003	6. Drain and retain liquid.
Worcestershire sauce	0.45	0.42	191	7. Shingle 10 steaks in each half-size steam table pan and set aside for step 10.
Water, cold	1.74	1.64	744	8. Add beef stock liquid to steam kettle. Make a paste of starch and cold water, add to stock.
Starch, Col-Flo-67	0.31	0.29	132	
Beef stock, liquid	22.31	21.00	9534	9. Heat to a boil and simmer 20 minutes. Bring volume back to 2.5 gallons (9.5 L) with hot water. 10. Add 2 lb (908 g) of gravy to each pan or boil-in-the-bag pouch of shingled cooked beef. 11. Cover and seal, label, and freeze.
Total	100.00	94.09	42713	

NOTE: Each pan yields 10 portions.

Table A6. Production Guide for Roast Beef

1. Choice grade inside rounds were trimmed of excess fat and other undesirable portions. The rounds were cut into roasts of approximately five pounds each.

2. The roasts were cooked in a rotating shelf oven set at 177°C to an internal temperature of 60°C.

3. The roasts were cooled, then sliced in 3-mm-thick slices.

4. Four pounds of sliced roast beef and one pound of Au Jus were placed into each foil pan or boil-in-the-bag pouch.

Table A7. Production Guide for Chicken Cacciatore

1. Recipe No. L130 Chicken Cacciatore from the Armed Forces Recipe Service[3] was followed. No modifications were made in the recipe.
2. Four pounds of chicken pieces and one pound of sauce were packaged in either half-size foil steam table pans or in the boil-in-the-bag pouches.

[3]U.S. Army. 1972. Armed Forces Recipe Service TM 10-412.

Table A8. Production Guide for Oven-Fried Chicken L-138

Yield: 100 portions Each portion: 2 pieces

Ingredients	Percentage	Pounds	Grams	Procedure
Chicken, broiler, fryer, cut-up	78.52	50.00	22700	1. Separate pieces of chicken into individual parts (wings, legs, thighs, breasts). Wash thoroughly. Drain well.
Milk, Nonfat, dry	0.63	0.40	182	2. Reconstitute milk with water; add eggs and mix thoroughly. Dip chicken in egg mixture. Drain and save for step 4.
Water	4.32	2.75	1249	
Egg, whole, beaten	3.14	2.00	908	
Flour, wheat, pastry	4.71	3.00	1362	3. Combine flour, salt, pepper, paprika and break crumbs, mix thoroughly.
Salt	0.79	0.50	227	
Pepper, black	0.01	0.01	5	
Bread crumbs, dry	7.86	5.00	2270	4. Dredge chicken in seasoned flour. Shake off excess.
Paprika, ground	0.02	0.02	8	5. Brown chicken in deep fat fryer at 365°F (185°C) for 2 minutes or until brown.
				6. Place browned chicken in open pans and bake at 350°F (176°C) in revolving oven to an internal temperature of 165°F (74°C) (45 minutes).
				7. Place 16 pieces (4 wings, 4 thighs, 4 legs and 4 breasts) in half-size steam table pan or boil-in-the-bag pouch.
				8. Cover or seal, label and freeze.
Total	100.00	63.68	28911	

NOTE: Formula makes 13 pans; each pan feeds 8 men.

Table A9. Production Guide for Turkey a-la-King L-129-1 Ch.2

Yield: 100 portions Each portion: 1 cup (240 ml)

Ingredients	Percentage	Pounds	Grams	Procedure
Shortening, melted	3.74	2.50	1135	1. Place shortening in steam kettle and heat. Stir in flour to make a roux. Cook for 10 minutes.
Flour, wheat, pastry	1.87	1.25	568	
Starch, Col-Flo-67	1.87	1.25	568	2. Mix starch, soup and gravy base, and water together and add to roux. Heat till thickened.
Water, warm	37.70	25.20	11441	
Soup & gravy base (chicken)	1.12	0.75	341	
Salt	0.28	0.19	86	3. Add seasonings and vegetables. Bring to boil, stirring constantly.
Pepper, black	0.04	0.03	14	
Onions, dehydrated, chopped	0.19	0.13	59	
Celery, fresh, chopped	7.48	5.00	2270	
Turkey, boneless cooked (roll) 1 inch dice	29.92	20.00	9080	4. Add diced turkey, peppers and pimientos to mixture and heat to 180°F (82°C).
Pepper, sweet, fresh, chopped	1.49	1.00	454	
Pimientos, canned, chopped	1.31	0.88	400	
Milk, nonfat, dry	1.22	0.81	368	5. Reconstitute milk, add to ingredients.
Water, warm	11.77	7.88	3578	
				6. Adjust volume to 7.5 gallons (28.4 L). Heat to simmering temperature. Do not boil. (180°F or 82°C).
				7. Weigh 5 lb (2270 g) of product into half-size steam table pans or boil-in-the-bag pouches.
				8. Cover or seal, label, and freeze.
Total	100.00	66.87	30362	

NOTE: Each pan serves 10 men.

Table A10. Production Guide for Pork Chop Suey L-80 (1)

Yield: 100 portions Each portion: 1 cup (240 ml)

Ingredients	Percentage	Pounds	Grams	Procedure
Pork, boneless diced,	48.78	32.00	14528	1. Brown diced pork in its own
Salt	0.40	0.26	118	fat, sprinkled with pepper and
Pepper, black	0.04	0.02	9	salt, in a steam kettle.
Water	14.00	9.18	4168	2. Cover pork with water provided; bring to a boil. Cover and simmer 1 hour.
Onions, dehydrated chopped	2.29	1.50	681	3. Rehydrate onions in excess water, drain, and add
Celery, sliced 3/16"	12.21	8.01	3637	rehydrated onions and sliced celery to kettle approximately 20 minutes prior to 1 hour cook of pork.
Bean sprouts (drained)	18.30	12.01	5453	4. Drain bean sprouts, re-
Starch, Col-Flo-67	1.90	1.25	568	serving liquid.
Ginger, ground	0.02	0.01	5	5. Combine the liquid from the
Soy sauce	1.53	1.00	454	beansprouts, starch, and ginger
Molasses, dark	0.53	0.35	159	Stir to make a smooth paste.
				6. Add slurry slowly to mixture stirring constantly. Cook 20 minutes or until thickened.
				7. Add bean sprouts, mix well.
				8. Stir in soy sauce and molasses. Blend well and adjust volume to 6.25 gallons (23.7 L).
				9. Weigh 5 lb (2270 g) into half-size steam table pan or boil-in-the-bag pouch.
				10. Cover or seal, label, and freeze.
Total	100.00	65.59	29780	

NOTES: 1. Volume - 6.25 gallons (24 L) or 100 portions
2. Fill weight - 5 lb (2270 g) serves 8.
3. Frozen sliced onions may be substituted for the dehydrated at the ratio of 8 parts to 1.

Table All. Production Guide for Baked Tuna and Noodles L-124

Yield: 100 portions

Each portion: 1 cup (9 oz or 225 g)
Temperature: 350°F (177°C) Oven

Ingredients	Percentage	Pounds	Grams	Procedure
Tuna, canned, white	28.30	17.00	7718	1. Drain tuna; flake. Set aside for use in step 7.
Noodles, dry medium	8.32	5.00	2270	2. Cook noodles in salted water (3 gallons) until tender (15-20 minutes). Rinse thoroughly and set aside for step 7.
Salt	0.18	0.11	50	
Milk, nonfat, dry	4.16	2.50	1135	3. Add dry milk and starch to water, mix thoroughly and heat slowly to 180°F (82°C). Hold for step 7.
Water, warm	39.95	24.00	10896	
Starch, Col-Flo-67	0.70	0.42	191	
Flour, wheat, pastry	1.42	0.85	386	4. Heat butter in large steam kettle, slowly add flour and salt. Mix thoroughly and cook for 10 minutes with constant stirring. 5. Gradually add heated milk-starch mixture to butter-flour mixture. Stir constantly, simmer for 20 minutes. Hold sauce for step 7.
Salt	0.27	0.16	73	
Butter or margarine	3.75	2.25	1022	
Celery, fresh, chopped, 1/8 inch dices	6.66	4.00	1816	6. Rehydrate onions in excess cold water for 10 minutes, drain well. Saute celery and onions in butter until tender. Set aside for step 7.
Onions, dehydrated, sliced	0.15	0.09	41	
Butter or margarine	0.70	0.42	191	
Pimentos, canned, drained, chopped 1/4 inch dices	1.42	0.85	386	7. Combine tuna, noodles, sauteed vegetables and pimentos with sauce from step 5. Mix thoroughly, heat to 165°F (74°C) and bring volume back to 6.5 gallons (2.5 L) with hot water. Place 5.75 lb (2611 g) in half-size steam table pan or boil-in-the-bag pouch.

Table All (cont)

Ingredients	Percentage	Pounds	Grams	Procedure
Cheese, cheddar, natural shredded	2.50	1.50	681	8. Sprinkle cheese evenly over pans of tuna.
Paprika, ground	0.10	0.06	28	9. Mix bread crumbs and paprika and spread evenly over cheese.
Bread crumbs, dry	1.42	0.85	386	10. Cover or seal, label, and freeze.
Total	100.00	60.06	27270	

NOTES: 1. Formula makes 10 pans; each pan feeds 10 men.
2. Twelve ounces (340 g) of fresh onions may be used in step 6.
3. Three and one-half gallons (13.3 L) of other types of milk may be substituted for nonfat, dry milk and water in step 3.